DOCUMENT RESUME

ED 464 592 IR 021 175

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TITLE Examining Learning Environmental Design Issues for Prompting Reflective Thinking in Web-Enhanced PBL.
PUB DATE 2001-03-00
NOTE 9p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 1-5, 2002).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cognitive Processes; *Educational Environment; *Instructional Design; Middle School Students; Middle Schools; *Problem Based Learning; Student Attitudes; *Student Reaction; Teacher Role; World Wide Web
IDENTIFIERS *Reflective Thinking

ABSTRACT

Reflection involves active, persistent, and careful consideration of any belief or practice. It promotes understanding of underlying beliefs and application of new knowledge to new situations. Problem-Based Learning (PBL) provides the instructional mechanisms for prompting learner reflective thinking. This study examines the following: factors that students perceive as prompting reflective thinking; which factor is perceived as the most important for prompting learners' reflective thinking; whether there is a significant difference between the derived factors; and which elements or characteristics prompt reflective thinking within the derived factors. Participants were 144 sixth through eighth grade students attending three different middle schools in rural Pennsylvania. The study found that young students perceived three factors as most important in supporting their thinking: learning environment, teacher, and scaffolding tools. Reflective factors are described and implications for designing PBL that can promote reflective thinking are discussed. The findings of this study have important implications for the design of PBL environments so that they promote reflective thinking. (Contains 20 references and 3 tables.) (AEF)

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Article submitted for presentation at the 2002 American Educational Research Association, New Orleans, Louisiana

March, 2002

Running Head: Factors that Prompt Reflective Thinking

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Reflection involves active, persistent, and careful consideration of any belief or practice. It promotes understanding of underlying beliefs and application of new knowledge to new situations. Problem-Based Learning (PBL) provides the instructional mechanisms for prompting learner reflective thinking. This study found that young students perceived three factors as most important in supporting their thinking: learning environment, teacher, and scaffolding tools. Reflective factors are described and implications for designing PBL that can promote reflective thinking are discussed.

Introduction

Modern society is becoming more complex, information is becoming available and changing more rapidly prompting users to constantly re-think, switch directions, and change problem-solving strategies. Thus, it is increasingly important to help young students develop keen reflective thinking capabilities during learning that help them construct strategies for applying new knowledge to complex situations in their day-to-day activities. Reflective thinking helps learners develop higher-order thinking skills by prompting learners to a) relate new knowledge to prior understanding, b) think in both abstract and conceptual terms, c) apply specific strategies in novel tasks, and d) understand their own thinking and learning strategies (Hmelo & Ferrari, 1997). PBL provides learners with instructional mechanisms that can increase their reflective thinking while exploring authentic and ill-structured problems, participating in social interactions, and receiving coaching from peers and teachers (Albanese & Mitchell, 1993; Donahuse, 1999; Hmelo & Ferrari, 1997). This mindful stance toward learning is essential for efficient development of reflective thinking and ultimately knowledge construction. However, the research on factors that may affect reflection during PBL is limited.

Previous studies have sought to identify factors that influenced reflection by looking at the activities in which learners engage during the PBL process (van den Hurk, et al., 1999). These studies have identified factors that may encourage reflective thinking but it is still unclear which factors the learner feels prompt valuable reflection. Answering questions such as how we support reflective thinking in a PBL environment requires identifying both the factors that might prompt reflective thinking and examining learner perceptions about those factors. Therefore, the purpose of this study was to identify factors that learners perceived as important in facilitating their own reflections during learning activities.

Examining research-based factors for prompting reflective thinking in a PBL environment would be helpful in several areas. First it would simplify the further analysis of factors prompting reflective thinking in PBL by reducing the number of variables. Second it would provide a meaningful and useful framework for discussing design factors that support learners' reflective thinking when participating in a PBL lesson in a classroom.

Theoretical Framework

Dewey's work was an attempt to reconsider the relationship of organism and environment. He stressed the continuous, intrinsic connection of organism and world on the level of action, and introduced

the notions of transaction and experience. Dewey (1933) introduced the concept "reflective thought." His most basic assumption was that learning improves to the degree that it arises out of the process of reflection. Reflection was a secondary phenomenon related to the level of an organism's action in a situation. Reflection ensures the continuity of action. Dewey believed that reflection arises because the organism (individual) detects the appearance of incompatible factors within a situation then develops opposed responses in an attempt to further engage in and understand the situation thereby constructing knowledge. Knowing therefore is not a process of registration or representation, but one of intervention. Knowledge is constructed, in part, through reflection, e.g., the active, persistent, and thoughtful consideration and participation in a situation (Dewey, 1933). The cycle of reflecting and constructing knowledge is thus determined by the changes one finds satisfactory about a new situation on the whole or by the discovery of new features that give the situation new meaning and change the nature of questions being explored during the learning and reflection processes.

Moon (1999) further clarified the concept of reflective thinking as a chain of ideas that is aimed at a conclusion and was more than a stream of consciousness; whereas, Canning (1991) believed that reflective thinking was a behavior that involved "active, persistent, and careful consideration of any belief or practice that promoted understanding of underlying beliefs and applying newly gained knowledge to new situations." These studies agree that reflective thinking included a process of analyzing and making judgment about what has happened. Reflective thinking experiences are associated with increased motivation, willingness to take risks, enhanced self-esteem, and independence.

Why is it important to support reflective thinking in a PBL lesson? We can find an answer in the characteristics of PBL. PBL provides an environment where learners encounter ill structured problem situations. In reality, PBL takes place in settings that are characterized by a great deal of ambiguity, complexity, variety, and conflicting values that make unique demands on the learner's skills and knowledge. As a result, learners in a PBL lesson are constantly making choices about the nature of practice problems and how to solve them. Learners must be able to change ill-defined practice situations into those in which they are more certain about the most appropriate course of action to pursue. Therefore, the ability to reflect while acting is necessary to maintain the essence of effective practice in a PBL lesson.

Prompting reflective thinking is especially important to young students because the students of this age are experiencing many developmental transitions. Reflective thinking doesn't occur in middle-level students spontaneously. According to King and Kitchener (1994), reflective thinking has seven developmental stages. Reflective judgment is in the seventh stage and the term that they apply to the most advanced stage in their model. People in the seventh stage who have reflective judgment can acknowledge that there is no right answer and that experts may disagree as to the best solution of a dilemma. King & Kitchener describe reflective judgment as similar to 'wisdom' that adults usually have. However, middle school students are in a different developmental stage than adults. The National Middle School Association reports that middle level students are in a transition period from concrete thinking to abstract thinking. Therefore, they need some supportive activities to prompt their reflection in order for them to make learning meaningful and active. Therefore, it is necessary to prompt reflective thinking for middle-level students who are in their concrete thinking stage.

How then, do we prompt middle school students' reflective thinking in a PBL lesson? Research suggests that various elements in PBL are related to prompting students' reflective thinking. Previous research indicates that tasks, teachers, instructional environments, and reflective thinking tools are key elements that support reflective thinking in PBL (Andrusyszyn, 1997; Lin, 1999; Moon, 199; Barrow, 1998). First, ill-structured, authentic, and complex tasks are known to promote reflective thinking. These features of the task help students think reflectively because they come from "real-world experiences, have no single formula for conducting an investigation to resolve the problem, and require more information to understand the problem situation" (Stepien & Pyke, 1997). Second, the role of teacher is important in

prompting reflective thinking during PBL. According to Virtanen et al. (1999), both facilitating teachers and traditional teachers are effective in a PBL environment. A teacher who prefers facilitative activities may help learners by asking reflective questions while a traditional teacher explains or directs important reflective concepts to students (Moon, 1999; Virtanen et al, 1999). Third, flexible and active learning environments are also important in prompting reflective thinking during PBL. Effective PBL requires a relaxed atmosphere that can promote cooperative and collaborative learning and is conducive to students and teachers exploring misunderstandings together (Michale & Susan, 1998). Finally, the scaffolding tools are important in prompting reflective thinking during PBL. Andrusyszyn & Daive (1997) and Kinchin & Hay (2000) posit that there are three main types of tools that scaffold reflective thinking: reflective journals, guiding questions, and concept maps.

However, incorporating these factors into PBL may or may not enhance reflective thinking. Learners may perceive different factors in the environment as important in promoting their own reflection. Therefore, understanding how learners perceive the importance of each factor in prompting their thinking about their learning is important in designing effective PBL environments. In this study we have examined the following research questions:

1. What are the factors that students perceive as prompting reflective thinking?
2. Which factor is perceived as the most important for prompting learners' reflective thinking?
3. Is there a significant difference between the derived factors?
4. Which elements or characteristics prompt reflective thinking within the derived factors?

Method

Subjects

One hundred and forty-four sixth through eighth grade students attending three different middle schools in rural Pennsylvania participated. Students were from 6 different classrooms; including 82 boys, 59 girls, and 3 who did not identify their gender.

Instrument

A survey questionnaire for measuring the perceived factors related to reflective thinking in PBL was designed by the authors based on the literature of reflective thinking. The instrument consisted of 10 items that were scored on a 5-point Likert scale from strongly agree (5) to strongly disagree (1). The survey was reviewed for content and face validity and then tested with a small sample of middle school children to establish readability. The Cronbach alpha reliability of the final survey was .890.

Data Source and Analysis

Quantitative data on the perception questions were collected prior to participation in Problem-based Learning lessons. Data were collected over a five-month period, between October 2000 and March 2001. Maximum likelihood extraction and varimax rotation method were conducted for the factor analysis, using the SPSS/PC+ statistical package.

Results

In response to the first research question, *what are the factors that students perceive as prompting reflective thinking*; three factors emerged from the data based using an Eigen value of 1.0. Based on the literature review about design attributes required for reflective thinking, these findings were encouraging. (See Table 1.)

Three items (teacher explanation, teacher question, and authentic task) were in the same factor 1, five items (having freedom in class, working with a partner, working with an ill-structured task, having

time to think, and drawing pictures) were in the same factor 2, and two items (answering questions and writing about my understanding) clustered in the same factor 3.

The main characteristics of factor 1 appear to relate to the teacher variable, those of factor 2 appear to relate to the student learning environmental variable, and those of factor 3 appear to relate to the tool variable for prompting reflective thinking

Table 1. Factor loading of elements that prompt reflective thinking in PBL

Item	Item content	Factor 1	Factor 2	Factor 3
3	When my teacher explains how to solve difficult tasks it helps me think more about what I am studying.	**.909**	.104	.217
4	When my teacher asks me how to solve difficult tasks it helps me think more about what I am studying.	**.566**	.297	.398
2	Working on activities in class related to real problems on earth or in our society helps me think more about what I am studying.	**.388**	.385	.208
7	Having freedom in class to explore topics I am interested in helps me think more about what I am studying.	.181	**.600**	
5	Working with partners during classroom activities helps me think more about what I am studying.	.122	**.491**	
1	Working on activities in class that have many different answers helps me think more about what I am studying.	.247	**.475**	.360
6	Having time to think about a question before answering helps me think more about what I am studying.	.428	**.460**	.116
8	Drawing pictures to illustrate my understanding of a topic helps me think more about what I am studying.		**.451**	.225
10	Answering questions about a topic helps me think more about what I am studying.	.172	.137	**.782**
9	Writing about my understanding of a topic helps me think more about what I am studying.	.182		**.600**

In response to the second and third research questions, which factor is perceived as the most important for prompting learners' reflective thinking and is there a significant difference between the derived factors, the highest ranked factor mean was the student learning environment factor (Factor 2, M= 3.87), followed by the teacher factor (factor 1, M= 3.62) and tool factor (Factor 3, M= 3.21). See Table 2.

Table 2. Paired samples t-test for factors

	Mean	Std. Deviation	t	df	Sig (2-tailed)
F1	3.62	.80	-4.209	140	.000
F2	3.87	.62			
F2	3.87	.61	8.471	142	.000
F3	3.21	.92			
F1	3.62	.80	5.243	140	.000
F3	3.21	.93			

A paired sample t-test analysis was carried out to compare the factor means scores in three factor groups. The paired sample t-tests indicated that there were significant differences between the factors. The mean score of factor 2 is significantly higher than that of factor 1 or factor 3 ($p < .01$). The mean score at

factor 1 is also significantly higher than that of factor 3 ($p < .01$). This result shows that students perceive the student learning environment factor (factor 2) as the most significant factor to help think reflectively. The student learning environment factor included student-centered attributes such as more flexible atmosphere, time, and tasks, peer tutoring activities, and bursts of activities incorporating a drawing. Therefore, students perceive a student-centered learning environment as prompting more reflective thinking than a teacher-centered environment that provides questions and explanations from teachers or a simple supportive learning environment that includes reflective thinking tools such as questions or writing.

In response to the fourth research question, what elements or characteristics prompt reflective thinking within the derived factors, the highest ranked elements, both of a social nature and loaded to factor 2, were having freedom to explore topics in class ($x = 4.10$) and working with partners ($x = 4.05$). See table 3.

Table 3. Mean and standard deviation of question lists

Item	Item content	Mean	SD
1	Working on activities in class that have many different answers helps me think more about what I am studying.	3.706	.93
2	Working on activities in class related to real problems on earth or in our society helps me think more about what I am studying.	3.63	.99
3	When my teacher explains how to solve difficult tasks it helps me think more about what I am studying.	3.71	.90
4	When my teacher asks me how to solve difficult tasks it helps me think more about what I am studying.	3.52	1.03
5	Working with partners during classroom activities helps me think more about what I am studying.	4.05	.94
6	Having time to think about a question before answering helps me think more about what I am studying.	3.90	.82
7	Having freedom in class to explore topics I am interested in helps me think more about what I am studying.	4.10	.94
8	Drawing pictures to illustrate my understanding of a topic helps me think more about what I am studying.	3.59	1.07
9	Writing about my understanding of a topic helps me think more about what I am studying.	2.94	1.13
10	Answering questions about a topic helps me think more about what I am studying.	3.48	.99

Conclusions, Limitations, and Importance to Instructional Design

Students perceived three major factors as most important in prompting their reflective thinking; student learning environment, teacher, and tools, ranked respectively. Of further importance was that the social activities within the environment were ranked as most important, demonstrating the importance of social learning to students. Previous research on the collaborative learning activities support the importance of social learning (Koschman, Kelson, Feltovich, & Barrows, 1996). Although the kids "liked" the collaborative activities, their teachers found them to be inexperienced in group decision-making and collaborative learning. Often teachers had to provide a great deal of scaffolding and coaching in such situations. They also instituted problem solving, decision making, and team building activities and experiences to help students become more productive during collaborative sessions. Further research is needed to investigate how to scaffold students for successful participation in collaborative activities.

Further research is also needed to examine how these three factors, student learning environment, teacher, and tools, interact with each other. Given that the student learning environment emerged as the most important factor, it is important to further refine and test the attributes of this factor. This process will help to determine whether there are other specific components in the learning environment that student perceive as prompting their reflective thinking.

The findings of this study have important implications on the design of problem-based learning environment so that they will prompt reflective thinking. Student-centered environments that have a more flexible atmosphere and provide many venues for social learning may have a stronger impact on learner's perception on reflective thinking. However, students at young ages may not be able to work effectively in such environments and require careful scaffolding by teachers and instructional tools. This research raised implications about students' perceptions of factors that prompt their thinking and learning. Designing PBL that prompts reflective thinking and ultimately deeper learning can be achieved by better understanding learner perceptions about factors that prompt their reflective thinking.

Acknowledgement: This project was made possible through funding from the National Aeronautics Space Administration, Leading Educators to Applications, Research, and NASA-Related Educational Resources in Science (LEARNERS), a Cooperative Agreement Notice from the NASA Education Division and Learning Technologies Project. Project Number: NCC5-432: Learning Using ERAST Aircraft for Understanding Remote Sensing, Atmospheric Sampling and Aircraft Technologies, (LUAU II).

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